The Dual Regimes of Digital Innovation Management

Fredrik Svahn
Viktoria Institute
fredrik.svahn@viktoria.se

Ola Henfridsson
Chalmers University of Technology
ola.henfridsson@chalmers.se

Abstract

The pervasive integration of digital technology in traditionally physical products such as cars, heat pumps, and washing machines calls for revisiting the received innovation literature. To this end, this paper presents a competing logic framework for understanding digital technology in product innovation management. In doing this, we derive two idealized innovation regimes by distinguishing and assessing two broad streams of innovation research across the dimensions of organizing logic, market dynamics, and architectural design. Recognizing and elaborating inherent tensions between product innovation and IT innovation, the framework identifies a range of new challenges with implications for digital innovation management research and practice.

1. Introduction

Established innovation practices make efficient barriers for humans to rethink technology and give it new meanings. As noted by Nelson and Winter [56], some directions of progression "seem much more compelling of attention than others. Particularly in industries where technological advance is very rapid, advance seems to follow advance in a way that appears almost inevitable". Such path dependency [9, 27] makes technology evolve according to an inherent logic that we cannot ignore. In the literature, such logic is variously termed as "technological regimes" [56], "technological trajectories" [30], "pattern of evolution" [43], "technological guideposts and avenues" [65], and "basic designs" [63].

At the same time, research also underlines that new technology may disrupt this logic. Ultimately, new technology may inaugurate the emergence of a new technological paradigm [38], seeding new paths of innovation. A new technological paradigm inevitably brings a shift in "principles, norms and ideology, rules and decision-making procedures", recognized by Godoe [38, p. 1034] as the transition to a new *innovation regime*. Such regimes make a new foundation for actors to form "expectations and actions in terms of the future development of a technology".

In this paper, we conceive of the pervasive integration of digital technology in traditionally physical products such as cars, heat pumps, and washing machines as an innovation setting where two innovation regimes meet. Over the years, product-developing firms have developed a product innovation regime based on the organizing logics, market dynamics, and architectural designs of manufacturing [77]. However, digital technology is inherently different from tangible products [cf. 95]. As transportation, heating, and cleaning is increasingly enabled by software and digital technology, the established product innovation regime is challenged. In other words, as product-developing firms increasingly engage in digital innovation, i.e., "the carrying out of new combinations of digital and physical components to produce novel products" [97, p. 725], they encounter a new innovation dynamics that is fed by two inherently different innovation regimes.

Appreciating Yoo et al.'s [97] call for research on digital innovation, the research question of this paper is: *how can we understand innovation management as digital technology is integrated in traditionally physical products?* Using a concept-centric literature review, we address this question by presenting a competing logic framework for understanding digital technology in product innovation management. We view innovation management as the organization and coordination of processes "transforming ideas into commercial outputs" [39, p. 3]. The framework is manifested as two idealized innovation regimes, which we contrast to highlight the inherent tensions between product innovation and IT innovation across organizing logic, market dynamics, and architectural design.

2. Comparing Innovation Regimes

In this section, we distinguish and review two distinct streams of innovation literature, which we label *product innovation* and *IT innovation*. They represent innovation regimes in the way they manifest particular views on innovation. We suggest that these regimes deliver inherently different theoretical explanations of innovation. To understand digital technology in product innovation management, it therefore

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becomes important to compare these differences and the tensions that digital innovation entails.

2.1 Methods

Following Webster and Watson [91], we first identified major contributions in leading journals for each stream of the literature. First, our review of product innovation included papers published in outlets ranging from prestigious management journals such as *Administrative Science Quarterly* and *Academy Management Review* to specialized journals such as *Research Policy* and *Journal of Product Innovation Management*. Second, the innovation literature centered on information systems and IT was collected from a variety of journals increasingly recognizing the inherently unique properties of IT [4, 5, 44]. For instance, management outlets such as *Organization Science* show increasing interest in IT innovation, illustrated by the framing of upcoming special issues [cf. 96]. Similarly, IS researchers show increasing interest in digital technology and innovation. This is, e.g., reflected in ISR's 20th anniversary special issue, where a handful of totally 15 research commentaries are explicitly framed in this direction [81, 97, 16, 80, 34]. Finally, we extended our literature database by (a) back-tracking citations in the identified publications, and (b) forward-tracking (using Google Scholar and Web of Science) articles that cited key articles included in the database. All in all, we ended up with an EndNote database containing more than 200 articles, associated with more than 40 concepts

After collecting the relevant literature, we adopted a concept-centric perspective [91] to make sense of the publications collected. In our initial analysis, we noted how the two literature streams were characterized by different key concepts. While the product innovation literature was distinguished by concepts such as dominant design, economy of scale, hierarchy, and modularity, the IT innovation literature was associated with installed base, two-sided markets, generativity, agility, networks, patterns, and so on.

Inductively, we then identified three main themes that were well represented in both streams of literature: artifact, organization, and market. Both literatures offer a technology-centric discourse, largely addressing the question of how to design technology to be resilient to change. Similarly, they both address the intricate question of how to collaborate, within and across firm boundaries. Finally, our analysis showed a shared emphasis on economic rationality and market evolution. Consequently, we centered our comparison of innovation regimes on these three key dimensions, eventually labeled *organizing logic*, *market dynamics*, and *architectural design*. Next, we elaborate these dimensions for product innovation and IT innovation respectively.

2.2 Organizing Logic

Following Sambamurthy and Zmud [67], we refer to organizing logic as the "managerial rationale for designing and evolving specific organizational arrangements in response to an enterprise's environmental and strategic imperatives" (p. 107). In what follows, we engage in a review of the organizing logic linked to a product innovation regime and an IT innovation regime respectively.

2.2.1 Firm-Centricity and the Exercise of Formal Control

In a product innovation regime, the organization is the epicenter of innovation activity and the natural container of innovation capability. A significant part of the research is focusing on challenges facing *incumbent firms* [84, 2, 40, 41], manufacturing *physical products* of significant *complexity*. The goods produced by different actors are homogenous, leaving relatively low price differentiation. As markets are occupied with such *dominant designs* [2, 79, 86, 63, 65] it makes perfect sense to view innovation as the fruit of *incremental progression* within organizations. In settings where material supplies are unreliable, production costly, and knowledge a scarcity, such incremental change is most efficiently managed through *hierarchical organization* structures [23, 92], hosting the development of *modular products* [73, 11, 68] under strictly *linear development processes* [37, 60, 78]. This translates to *vertically oriented industries* [20] where competitive advantage derives from an organizations capability to enforce absolute control over its entire value chain. Following transaction cost theory [24, 93] the vertical integration we see in product developing organizations illustrates that it is cheaper to administer incremental innovation processes internally than outsource it to a market [18, 48]. In this context, it is worth noting that incremental innovation does not condition new ideas to derive from internal processes. However, it prescribes a distinct way for organizations to absorb new ideas; they are mangled through existing practices to align with established knowledge, organizational structures, and products.

While incremental progression seems to be the dominant mode of innovation in product developing settings, the literature pays substantial attention to change processes where firms are forced to *rethink* established knowledge, routines, and organizational structures. It acknowledges that relatively stable periods of incremental innovation are recurrently interrupted by technological breakthroughs or radical

innovations, overturning existing paradigms and, eventually, seeding new paths of incremental change. Such disruptions are potentially lethal to organizations tuned for incremental innovation. To maneuver in the uncertainty introduced by radically new technology organizations have to build capability for creative destruction [1, 70]. Essentially, such capability allows for the development of new knowledge, coming at the expense of existing explanations to everyday problems. As pointed out by Henderson and Clark [40], such destruction is particularly problematic when the innovation changes the architecture of a product, since architectural knowledge tend to be deeply embedded in organizational structures and information-processing procedures.

As a whole, a product developing organization is a highly teleological machinery. There is an up-front plan for design, sourcing of components, systems integration, verification, assembly, and shipping. Competitive advantage emerges out of a capability to make this machinery work in concert. Hierarchical organizations, linear models of product development, and vertical industry structures simply seem to be the dominant organizing logic allowing product developing organizations to build such capability.

One lens to understand this dominance is offered by control theory, in turn deriving from transaction cost economics. Incremental innovation practices are highly visible within firms and, thereby, provide significant "knowledge of the transformation process" [58]. When organizations know in detail how behaviors and processes will transform inputs into outputs it is cheaper to apply formal behavioral control than informal output control. Therefore, incremental innovation tends to feed such *formal control modes*, centered on authority [32, 47] and maintained by the various distinctive properties of a product innovation regime.

2.2.2 Network-Centricity and the Creation of Digital Options

A salient distinction between traditional product innovation literature and IT innovation is that the firm-centric view is largely shifted out. Technological progression is not seen as a phenomenon deriving from linear development processes, hierarchical organizations, and vertical industry structures. Instead, IT innovation research underlines that digital technology destroys many barriers favoring incumbent innovation. Over time this cultivates *boundary-spanning practices* [51, 53], involving an increasing variety of largely uncoordinated innovation sources [94]. As a result, innovation translates into a *distributed activity* [99, 95]. Taking place in *networks* [89, 14, 83] or *ecosystems* [12, 71], rather than within

hierarchies, such innovation feeds significant multiplicity in functions and services.

Distributed value creation, scattered across networks and ecosystems, "leads to the emergence of dynamic, non-linear patterns of digital innovation" [98, p. 3]. Such *non-linear innovation* provides value, not by outperforming existing products, but through the establishment of genuinely new value networks [22, 101]. Navigating in a distributed innovation environment, where ideas and knowledge derive from external sources at the bottom of a market, requires firms to organize for agility [66]. Agility, referring to the ability to detect and seize market opportunities with speed and surprise, is considered to be an imperative for success in an IT innovation regime [15, 22].

Taking an industry perspective rather than a firm perspective, an IT innovation regime seems to feed *horizontally segmented industries*. To survive in distributed innovation ecosystems, firms have to focus on building their distinctive competences, outsource the rest, and become nodes in value chain networks [89]. As illustrated by the transformation of computer industry [19], accelerating pace of technological change and fierce competition forces manufacturing firms to focus on horizontal segments, rather than remaining vertical organizations.

With limited power to influence the details of innovation processes, firms operating in IT innovation regimes are directed to informal governance, controlling the *output*, rather than behavior. It is easy to argue that the inability to get involved increases the risk for a given firm. As expressed by Fichman [35] an IT innovation regime brings "uncertainty about expected payoffs [of engagement] and irreversibilities in the costs of implementation" (p. 132). Uncertainty derives e.g. from unpredictable evolution of a particular technology, potentially creating unwanted path dependencies. Irreversibility may arise from high learning and adaptation cost, as well as high switching cost, when phasing out a technology.

Open, distributed innovation "allows companies to scan a much wider range of the available technologies or new market developments" [90, p. 253], without mandatory commitments. Therefore, it makes a complementary mechanism that balances the risk of specific initiatives. An IT innovation regime *gives a firm access to options that do not have to be exercised*. Such rights, without obligations to take actions in the future are frequently discussed, across scientific disciplines, under the notion of *real options*. This concept extends from finance literature, where it is applied for decision-making processes under uncertainty [29]. However, in the 90th it emerged as a theoretical lens in strategic management [6], making a tool for firms to build managerial flexibility [82].

As demonstrated by Vanhaverbeke et al. [90], real option theory makes a excellent tool in understanding governance and organizing logic in IT innovation. Many researchers have stressed the need to rethink the trade-off between incentives and authority in governance [28, 57, 72]. This argument is rooted in an increasing awareness of co-opetition, i.e. simultaneous competition and cooperation [88]. Progressive IT innovation is built around symbiotic relationships, formed to create mutual value for its members [12]. Instead of elaborating rather fuzzy tensions between informal, incentives-driven governance and formal, authority-based control, one can argue that *governance in IT innovation is about the creation, maintenance, and, eventually, realization of options*. Such options "create value by generating future decision rights and, in this way, providing strategic flexibility. This flexibility is more valuable the higher the level of uncertainty" [90, p. 252]. With this perspective on governance in IT innovation, one can say that IT is a "digital options generator" [66, p. 238].

2.3 Market Dynamics

We refer to market dynamics as the mechanisms defining the forces of demand and supply at markets. On a general level, the market dynamics explains why a producer is prevented from giving the consumer what it ultimately wants and vice versa. It defines the equilibrium of a market and the rules for moving this balance point.

2.3.1 Competition over Price under Dominant Designs

Largely, product innovation research explains the relative uniformity at the level of markets through the concept of dominant design. At some point in the evolution of a technology the industry is moving from a system of "made-to-order" products to a standardized mass-market manufacturing system of a complex assembled product [3, 2]. This turning point between flexible and specialized production marks the transition into a dominant design. The emergence of a dominant design is a subtle process which can be recognized in retrospect, but is almost impossible to appreciate in real time [8]. Concurring with Murmann and Frenken [55], Abernathy [3] identifies three distinct phases in the materialization of a dominant design. The first step is characterized by the introduction of a solution with broader appeal in contrast to earlier product variants that focused on performance dimensions valued by only a small number of users. In the second phase, attention is shifted away from performance and basic functionality towards the details of design as increasing market shares impose imitative design reactions among

players competing at the same market. Finally, the dominant design is established as imitative behavior eventually enforces standardization throughout the industry and almost complete diffusion across markets.

There are several perspectives in the literature discussing the causal mechanisms behind dominant designs. One stream of research emphasizes that a dominant design becomes dominant simply because it delivers the best technological compromise among the different functional characteristics of the technology [2, 76, 87]. Other researchers focus on the self-reinforcing nature of dominant designs and argue that those designs initially gaining the lead in market share often will become dominant [25, 52]. Another recurring perspective on dominant design is based on the idea of network externalities [13, 64]. The key point of this argument is that dominant designs are encouraged if the value of a particular technology depends on the number of other users who have adopted it [27, 9]. Finally, the most straightforward explanation to dominant design in product innovation literature derives from theories on economies of scale. Dominant designs simply are economies of scale that can be realized through direct sales of standardized products [49, 42]. Therefore, as dominant designs emerge market competition is shifted from functional performance to price [79].

2.3.2 Competition over Attention through Shared Platforms

Since competition over price is inherently related to an industry's dominant design, it makes a stable point of departure when trying to distinguish between our two innovation regimes. *Producing tangible products entails significant fixed and marginal cost, while producing software does not*. Tracing the cost of a car or airplane we will find that a majority is related to production tools, supply chains, factories, and distribution, but also to the marginal cost, such as materials making up the physical artifact. In contrast, the cost of software derives almost exclusively from design.

An innovation regime characterized by the absence of marginal cost and limited fixed cost induces new incentives and, therefore, give rise to a new market logic. At the heart of this new logic we find a story about an abundance of critical resources. In IT innovation, the bottlenecks standing behind a demand-side and a supply side are inherently different from the barriers in a product innovation regime. Software is realized, shipped, and consumed electronically, *without* consuming scarce, physical resources. Essentially, this eliminates price as a dominant force in innovation. Ultimately this promotes markets of infinite choice.

A central argument in the "The Long Tail" [7] is that scarcity of fundamental resources in product innovation *enforces* dominant designs. As products are increasingly digitized scarce resources are gradually marginalized and "the mass market is turning into a mass of niches" (p. 5). That way digital technology has "unleashed an extraordinary possibility for many to participate in the process of building and cultivating a culture that reaches far beyond local boundaries" [50, p. 9]. Such power changes markets and threatens established content industries.

Then, as multiplicity explodes in the wakes of digital technology, what drives competition? What are the scarce resources of IT innovation? As pointed out by Bill Gates in a Wall Street Journal article, the scarce resource is *attention*. On the one hand, profit may skyrocket as soon as design cost is covered. On the other hand, "your demand can literally almost drop to zero" in the moment when someone comes up with a superior solution and user attention is shifted away. Although this phenomenon is frequently discussed in the literature [cf. 26], it is particularly well articulated by Herbert Simon [74]. What information consumes, says Simon, is "the attention of its recipients. Hence a wealth of information creates a poverty of attention and a need to allocate that attention efficiently among the overabundance of information sources that might consume it." (p. 40) This translates well to digital markets. Multiplicity of software applications creates poverty of attention and a strategic need to allocate that attention efficiently across potential customers.

Trying to set up such strategies it is critical to take into account that digital markets increasingly are taking the form of two-sided markets [31, 33]. Two groups – here end-users and application developers – are attracted to each other through at phenomenon identified by economists as the network effect [46, 64]. The value of a particular network is largely depending on the number of users on the other side of the network. Game developers will direct their attention towards a community offering a critical mass of players. Similarly, players will favor communities with great variety of games.

As two-sided markets are increasingly important, competition is shifted towards platform-centric ecosystems [46, 81]. In such ecosystems, platforms are "products and services that bring together groups of users in two-sided networks" [33, p. 94]. This perspective downplays the tangible dimensions of the product and put attention on the "infrastructure and rules that facilitate the two groups' transactions" [33]. This marks a distinction towards other perspectives on the concept of platforms, discussed in marketing, software engineering, or product development [45, 62].

2.4 Architectural Design

The more expensive, complicated, and ephemeral a product or service is, the more important it is to build on earlier achievements. Architecture has therefore gained a prominent place in the product innovation literature as well as research centered on IT innovation.

2.4.1 Product Architecture: Modularity and the Reuse of Assets

As underlined by Sanchez and Mahoney [68], a properly composed architecture may provide a form of "embedded coordination that greatly reduces the need for overt exercise of managerial authority to achieve coordination of development processes, thereby making possible the concurrent and autonomous development of components by loosely coupled organization structures" (p. 64). Today an overwhelming majority of manufacturing firms develop their products on the basis of modular architectures. The idea of modularity is grounded in the concept of near decomposability [73]. In a product innovation regime, discussing near decomposability in terms of modularity, the notion of component generally refers to the physical, tangible building blocks that together aggregate into a product. Therefore, when talking about modular structures, the architect normally refers to a hierarchy of such physical components.

Let us then ask how organizations can change their products in order to improve price/performance ratios when markets are characterized by dominant designs. Turning to the literature, it is relatively straight-forward to claim that dominant designs enforces *change in the details, while preserving structures of the system as a whole*. As emphasized by several re-searchers, a dominant design is characterized by a set of core design concepts, corresponding to the major functions of a product [23, 54, 40]. It also comes with a general idea of how these core design concepts are em-bodied in physical components and eventually inte-grated into a product [23, 65, 40]. "Once any dominant design is established, the initial set of components is refined and elaborated, and progress takes the shape of improvements in the components within the framework of a stable architecture" [40, p.14].

Structuring the parts of a system according to the principles of modularity allows them to focus their design attention on the internal properties of components. With this approach it is possible to feed markets with variety and change, while at the same time trying to preserve stable system solutions to conserve development and production resources for scale advantages [62]. Competitive advantage on markets characterized by dominant designs grows from the capability to continuously fine-tune the fitness of a

relatively stable overall system solution by adapting its different parts [40, 23, 2]. Product innovation regimes feed *reductionist perspectives on complexity*, normally addressed by modular product architectures.

As we know, a product innovation regime exercises linear models of product development. This prevailing model of innovation can be traced to a strong need to reduce ambiguity about the physical structure of the product [37]. Relying on formal control modes and strictly linear development processes organizations have to change their locus, from functional design to physical design, at an early stage. By the time a design is released for production functional properties are inevitably frozen [11]. Clearly, the deployment of functional structure to physical structure is a critical moment, defining how a product can be changed both within the life cycle and across generations [85]. As a consequence, the interplay between functional structure and physical structure is highly visible in the architectural thinking in product innovation literature.

Even more important in a context where functionality is frozen early in design processes, the product architecture defines "the degree to which a system's components can be separated and recombined" [69, p. 312]. Loosely coupled components are simply significantly easier to reuse and reconfiguration for new purposes. In fact, modularity exponentially increases the number of possible configurations achievable from a given set of inputs, which greatly increases the flexibility of a system [10, 69]. This makes an almost priceless capability for product developing firms to moderate variation and change without redefining a system solution or, ultimately, even the components of the system.

2.4.2 Software Architecture: Generative Designs and the Reuse of Ideas

Over the last two decades, service-oriented computing [5, 59], pattern-oriented software architecture [36, 17], and other theoretical perspectives have reinforced the idea that architecture is not just a set of tools for the structural transformation of the software system as an artifact, but a strategic tool guiding the gradual transformation of functionality.

The locus of attention seems to *shift from the complexity of artifacts to the complexity of problems*. With a growing focus on problems, software architects increasingly recognize that in order "to study and analyse a problem you must focus on studying and analysing the problem world in some depth, and in your investigations you must be willing to travel some distance away from the computer" [44, p. 9]. Distancing themselves from the computer, many designers and architects see in software what

Alexander saw in buildings; *good design is an emergent phenomena*. Context is certainly not static, neither are the problems defined by context. Therefore, it is increasingly emphasized that architectural design is less about the identification of generic structures of software systems *per se*, but rather a matter of identifying, describing, and using the generative schemes helping us to create what Alexander refers to as "living structure", valid across contextual barriers.

Seeing design as an emergent process is largely incompatible with a reductionist perspective on complexity. In contrast to a traditional product development setting, software architects increasingly find themselves not knowing exactly what they are architecting for. A software platform, such as Android, offers a whole range of generic elements, yet we have no clear idea of how these elements will be used and combined to form the applications of tomorrow.

IT innovations evolve in networks, centered on a shared platform that makes a tool to orchestrate a variety of heterogeneous knowledge in the harsh competition over attention. Such networks – or ecosystems – are generally not up-front assembled to support a specific purpose or a given product. Rather they emerge in response to opportunities offered by a general platform [71, 81, 46]. Referring to the work of Zittrain [100], we can argue that a platform able to trigger "voluntaristic and spontaneous innovation" in "heterogeneous and essentially uncoordinated crowds" [61, p. 210] holds generative capacity. Obviously, such generative capacity is a phenomenon found in the interplay between technology and social structures.

Still, reuse is a central aspect in IT innovation. It is just not about the reuse of material things, such as tools or physical components. If we listen to the proponents of pattern-oriented design it is not even about the reuse of software components or code, it is about the *reuse of ideas*. The shared platforms, making a center of gravity in successful innovation ecosystems, represent a pattern language. This pattern language offers both a way to identify the core design problems of a particular application domain and replicable rules and building blocks for their solutions [75].

For manufacturing organizations it is crucial to design products so that it is possible to reuse plants, production tools, processes, and organization structures to meet future challenges. In general, they architect their products according to the principles of modularity so that these massive investments can be covered by a range of variants and across generations of designs. As a contrast, an IT innovation regime increasingly recognizes ideas, solutions, patterns, and functions as key elements for reuse in a combinatorial evolution of technology. Competitive advantage grows from the capability to explore and exploit these elements

internally as well as externally [21]. In an IT innovation regime this pushes organizations to architect generative software systems, allowing essentially unrelated and unaccredited audiences to build and distribute code and content [100].

3. Discussion

As evidenced in our study and illustrated in Table 1, the product innovation and IT innovation literatures provide a significantly different outlook on innovation. As products are digitized, however, these two innovation regimes inevitably meet in the practice of innovating new products with digital capability. Given the quite polarized views, it can therefore be hypothesized that tensions between competing logics will be difficult to avoid. In fact, such tensions appear in each of the innovation regime dimensions.

Table 1 Competing logics in digital innovation.

	Product Innovation	IT Innovation
Organizing logic	Linear processes	Non-linear processes
	Behavioral control	Output control
	Vertical industries	Horizontal industries
	Teleology	Evolution
	Flexibility	Agility
	Firm-centricity	Network-centricity
Market Dynamics	Direct sales	Two-sided markets
	Competition over price	Competition over attention
	Marginal cost	Fixed cost
	Economy of scale	"a mass of niches"
	Dominant Designs	Shared Platforms
Architectural Design	Physical structures	Functional structures
	Complexity of artifacts	Complexity of problems
	Reuse of assets	Reuse of ideas
	Hierarchy	Network
	Change at the level of details	Change at the level of specifics
	Reductionism	Emergence
	Modular designs	Generative designs
	Early binding	Late binding

First, with regard to *organizing logic* [cf. 97], a key consequence of the transition towards horizontally structured industries, networked collaboration forms, and largely non-linear, open innovation processes is that once effective governance mechanisms are increasingly useless. While product innovation cultivates *firm-centricity and exercise of formal control*, a prospering IT innovation ecosystem supports *network-centricity and the creation of digital options.* For the firm engaged in digital innovation, the network-centricity introduces uncertainty that counteracts the traditionally exercised formal control over the product innovation process. In order to understand this

dynamics, more research is needed on the theories, methods, and best practices that can help us understand and overcome these opposing logics.

Second, in the case of *market dynamics*, the product innovation regime essentially supports *competition over price under dominant designs.* This involves an economy of scale-model, centered on driving down marginal cost through investment in production technology. Contrary to this regime, the key to profitable IT innovation is found in the capability to *compete over attention through shared platforms*. IT innovation increasingly faces the abundance of two-sided digital markets, kept together through shared platforms. Rather than competition over price, deriving from a dependence on scarce material resources, such markets are characterized by a competition over attention. For innovation to prosper the shared platform has to be able to facilitate the two groups' transactions, which at the end of the day requires substantial diffusion across the market. For the firm engaged in digital innovation, competition over attention challenges the traditional innovation regime where price is the dominating market dynamics logic. There exists little, if any, research that deals with the challenge to accommodate both innovation regimes in digital innovation.

Lastly, in terms of *architectural design*, the IT innovation regime emphasizes *the reuse of ideas* rather than *the reuse of assets*. While modularity is important, it is even more important to support generative designs. Seeking such generativity, designers tune functional structures for multiplicity and growth, rather than physical structures for commoditization. Further, a product innovation regime practices early binding of functionality to allow for nearly algorithmic production. In contrast, IT innovation allows for functionality to change across the life cycle of a product. In this regard, digital innovation faces opposing logics in terms of architectural design, meaning that the digital product-developing firm must handle heterogeneous architectural designs at the same time. A digital product must be manufactured, yet it must be open and generative to feed new functionality through platform ecosystems. Needless to say, more research is needed on the architectural challenge faced by firms engaged in digital innovation.

4. Conclusions

A salient feature of digital innovation is that product-developing firms need to accommodate two innovation regimes in the same innovation process. Since these innovation regimes largely embody two different rationales across organizing logics, market dynamics, and architectural design, the increasing digitization of physical products poses new challenges for modern product innovation management. It

increasingly involves the governance of both regimes simultaneously. Inevitably, such governance cannot escape tensions, but needs to thrive with the opportunity and learn from parallel regimes in order to cultivate successful digital innovation.

In this paper, we have presented a competing logics framework for understanding digital innovation regimes, as they co-exist in the practice of innovation management. Of course, future studies could address several limitations in our work. We draw on a literature review, meaning that further research needs to be conducted to verify how the two regimes presented here play out in practice. In particular, it would be useful to understand the dynamics that emerge from their interaction. In addition, it would be useful to use our concept-centric literature review to build specific theory-testing research designs that can enhance our early understanding of digital innovation in our field.

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